THE USE OF MICRO-SILICA TO IMPROVE THE COMPRESSIVE AND FLEXURAL STRENGTH OF CONCRETE

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Abstract- In present era vast development occurred in the field of concrete technology. Many research scientists and research fallows have been developed numerous techniques to improve the strength & durability parameters of the concrete. This present research work is mainly focused on one of such method in which silica fume is used to improve the compressive and flexural strength of concrete. It gives the brief information regarding how exactly silica fume affects strength and durability parameters like compressive strength, flexural strength of concrete. Various samples of M20 grade concrete were taken with water cement ratio as 0.5 to show the effect of silica-fume additions as 0%, 7.5% and 10% of binder replacement. The results show significant increase in compressive and flexural strength of concrete up to certain percentage of silica fume addition.

Keywords- Silica fume, Compressive strength, Flexural strength, Durability, Concrete.

I. INTRODUCTION

Silica fume is a byproduct resulting from reduction of high purity quartz with coal or coke and wood chips in an electric arc furnace during production of silicon metal or ferrosilicon alloys (Verma et al, 2012). Silica fume, also referred to as micro silica or condensed silica fume, is another material that is used as an artificial pozzolanic admixture (Kohno 1989; Gautefall 1986). Condensed silica fume is essentially silicon dioxide (more than 90%) in nanocrystaline form. When pozzolanic materials are incorporated to concrete, the silica present in these materials react with the calcium hydroxide released during the hydration of cement and forms additional calcium silicate hydrate (C – S – H), which improve durability and the mechanical properties of concrete. (Concrete Technology, M.S. Shetty - 2007)

High strength concrete refers to concrete that has a uniaxial compressive strength greater than the normal strength concrete obtained in a particular region. High strength and high performance concrete are being widely used throughout the world and to produce them, it is necessary to reduce the water binder ratio and increase the binder content. High strength concrete means good abrasion, impact and cavitations resistance. Using high strength concrete in structures today would result in economical advantages (Igarashi et al, 2005).

Most of the increase in cement demand could be met by the use of supplementary cementing materials, in order to reduce the green gas emission (Bentur, 2002). Industrial wastes, such as silica fume, blast furnace slag, fly ash are being used as supplementary cement replacement materials and recently, agricultural wastes are also being used as pozzolanic materials in concrete (Sensale, 2006).

Nowadays whole world is facing a major problem of environmental pollution these materials fly ash micro silica, steel slag may become a major pollution materials.

So, if we use this micro silica in concrete for construction we indirectly protecting our environment. None of the research article firmly explaining at what concentration it should be used. Therefore present investigation has been carried out to highlight the same.

II. MATERIALS AND METHODOLOGY

The binders used are Ordinary Portland cement and micro silica. The chemical composition and physical properties of the cementitious binders are summarized in Table 1. The coarse aggregate consisted of 19-mm maximum size basalt with a specific gravity of 2.6 and a fineness modulus of 6.87. The fine aggregate consisted of river sand with a maximum characteristic size of 4.75 mm, a fineness modulus of 2.45 and a specific gravity of 2.6.

Aggregates, Cement and SF have been mixed by hand succession with appropriate proportions for dry mix followed by addition of water sufficiently to achieve uniform and high workable mix.

The concrete has been placed in 150 mm cube, 150mm diameter and 300mm high cylinder with hand compaction by tamping rod. Curing regime has been taken as 24 hours in mould with hessian clothes at (20 – 24)^{0}C followed by underwater curing until the day of testing.

In hardened state 3days, 7 days and 28 days compressive strength of cubes and cylinder, flexural strength have been measured.

Table 1

Constituent/property	OPC
Lime Saturation Factor	0.92
Alumina Iron Ratio	1.16
Loss on Ignition	1.29%
Insoluble Residue	0.84%
Sulphuric Anhydride (SO_3)	2.03%
Magnesia (MgO)	1.16%
Alkalies	46%
Chlorides	0.02%
Compressive Strength (MPa)	
3 days	16
7 days	22
28 days	33
Specific Surface	303 m^2/kg
Specific Gravity	3.15

Table 2

Composition of the concrete mixtures (Kg/m³) and costs per m³ of concrete							
Mix	w/b	OPC	Micro-silica	Fine Aggregate	Coarse Aggregate	Water	Cost (Rs.)
NC	0.5	414	0	0.3933	0.8556	0	4376
NC + 7.5% M-S	0.5	382.95	31.05	0.3933	0.8556	0	4974
NC + 10% M-S	0.5	372.6	41.4	0.3933	0.8556	0	5173

Figure 1

Figure 2

III. RESULT AND DISCUSSION

In this present research work 3 (three) mix of concrete incorporating undensified silica fume are cast to perform experiments. The task were carried out by replacing cement with different percentages of silica fume at a single constant water-cementitious materials ratio keeping other mix design variables constant. The silica fume was replaced by 0%, 7.5%, and 10% for water-cementitious materials ratio for 0.50. For all mixes compressive strengths were determined at 3 days, 7 days and 28 days for 150 mm cubes. The experimental results showed that compressive strength for certain replacement of silica fume (i.e. at 7.5% is higher than control concrete (i.e. concrete at zero percentage silica fume replacement level) at all ages (i.e. at 3days, 7 days and 28 days).

It was observed that the maximum compressive strength is obtained at 7.5% silica fume replacement levels and thereafter compressive strength is decreased. Higher compressive strength at 28 days of about 49.33 MPa for 150 mm cube is obtained at 7.5% cement replacement by silica fume. But in normal concrete without silica fume at 28 days compressive strength of about 42.67 MPa for 150 mm cube is obtained. It is observed that 28 days compressive strength is increased by 13.5% for 150 mm cubes.

Table 3

Days	Compressive Strength		
	Normal Concrete	7.5% Silica fume + Normal Concrete	10 % Silica Fume + Normal Concrete
3 day	7.452	15.793	9.274
7 day	11.711	20.089	13.244
28 day	29.120	45.333	38.235

Table 4

Days	Flexural Strength		
	Normal Concrete	7.5% Silica fume + Normal Concrete	10 % Silica Fume + Normal Concrete
3 day	0.72	1.65	1.43
7 day	1.18	2.32	2.06
28 day	3.46	4.56	4.12

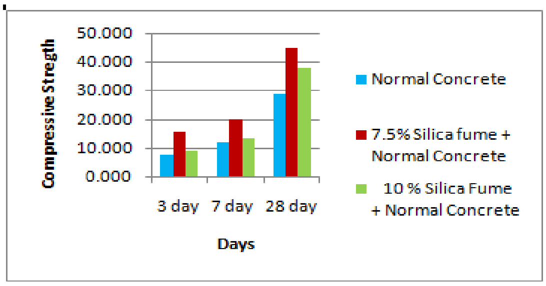

Figure 3

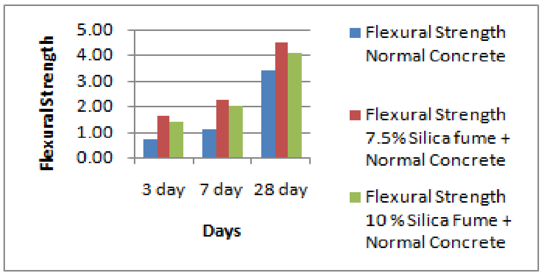

Figure 4

CONCLUSION

1. It can be concluded that 7.5% replacement of cement by Microsilica can induce higher strength properties to Normal Concrete.
2. Thus Microsilica can be used in the production of concrete to achieve higher strength.
3. The use of micro-silica also helps in reduction of Air Pollution.

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